

# Quantum Field Theory for Philosophers

Revised summary version

Note Date Oct 1982

## Introduction

- 1) QFT as a guide to metaphysics  
- Broad of interpretive problem for
- 2) Classical concept of field <sup>per So</sup>  
Field v. particle theory assumes complementarity of QFT description slide 1
- 3) What do we mean by an individual? - TI.  
- spatio-temporal content of trajectory, but in QM it is indeterminate
- 4) Field approach to classical particle physics - slide 2  
Newton 'On the Gravity and Equilibrium of Fluids'
- 5) Quantum Field Theory

Two approaches: Field quantization } slide 7  
Second quantization }

Field / Under determination Thesis  
Field quantization - slide 18 (19)  
Basic report of QFT - slide 30

Creation/annihilation operators - slide 20  
→ in 2<sup>nd</sup> quantization slide 21

- 6) Quantum Field from classical in 2 cases.

- Replaces
- 1) real field v. complex field
  - 2) Born - classical field limit ||  
v. Fermi - classical particle limit
  - 3) non-relativistic (Bohr) v. relativistic
  - 4) Weyl's programme.

can be formulated in particle approach → 5) causality conditions - slide 24  
Sufficient condition: Born or Fermi  
→ per field theory → Spin Statistics Theorem slide 25



## 7.) Creation / annihilation particles in classical mechanics slide (17) and (18)

9.5.2016 Kalam - Muta-hallamun 12<sup>th</sup> p. Haimonaden

25 min  
8) Wave - particle duality Subfielder of all equivalent respect. No does it cannot with  $\psi(x, t)$  and  $\phi(x, t)$ .

slide (22)

Dirac quote: {as he chooses}  
A complete harmony between the wave and light-quantum description of the interaction [between classical and quantum physics]

30 min

9) Matter & Fields slide (12)

of Bohr's program, say laws, C.V.T.S., supergravity, Unification of fields matter.

35 min

[10] What do we mean by verification?

F/H v. say they verification?

11) The Problem of Inductuality

Elem. particles do not possess TI  $\therefore$  re-included.

40 min

Stat. Mechanics argument - slide (13), (14).

limitation on accessibility of states if TI is assumed.



## Vacuum and Virtual Particles

12.)

Vacuum

$\rho_0 = 0$

fluctuates in  $|\Omega\rangle$  as

explains Lamb shift - Common effect of extended particle interaction.

add (23)

45 min

13.)

Virtual particlesExpand  $|\Phi'\rangle$ 

$|\Phi\rangle +$

- virtual particles  
obs. $H_0 + H'$  start in terms of  $H_0$  operators

add (16)

- Internal lines of Feynman diagrams

- no direct correlation with vacuum fluctuations, which do not require interaction

14.)

Conclusion

we have argued for a formal theory of underdetermination as between field and particle approaches to the elementary particles.

But there are extra logical arguments for preferring the field approach.

a) Any philosophical argument against TI tells against the particle approach

b) Heuristic value of field theory - In particle approach field quantities are very confused and hard to interpret.



We introduced two broad metaphysical categories

Continuants reidentified through time by TI

Ephemerals Distinguishable at a given time but not reidentifiable if relations of spatio-temporal continuity apply.

Final Remark

Although classical wave configurations are examples of ephemerals this does not mean that the elementary 'particles' are just waves. We have argued that they do not possess TI. So the substantial aspect of 'particles' is lacking for the elementary 'particles' in the philosophical sense of substantial. But like the Cheshire cat, although the substantial particularity has gone, there remains a particle grin. The elementary 'particles' are not particles but they are also not classical-type fields. They are quantum fields - ephemerals with a particle grin. And if you want me to stick my neck out this is the ultimate nature of reality according to modern theoretical physics

50 min